

## **SECTION V - STORM DRAIN**

### **V-1. GENERAL STATEMENT:**

It is the general purpose of these standards that waters generated by storms, springs or other sources be contained on the area to be developed or carried through a system of waterways and conduits and disposed of in such a manner that adjacent improvements, existing or projected, will be free from flood hazard. Flood hazard is defined as potential damage by water having sufficient depth or velocity to damage improvements or to deposit or scour soil other than within channels.

These specifications are further intended to meet the requirements of the National Flood Insurance Program. Any project that is located within the Flood Insurance Rate Map (FIRM) limits designated as subject to flooding shall be designed in such a manner as to be a minimum of one-foot above a 100-year flood and a properly prepared and executed Elevation Certificate shall be filed in accordance with the provisions of the Federal Emergency Management Administration (FEMA).

These standards are intended to provide general and some detailed design criteria. Most design details are left to the responsibility of the consultant and may be handled by following good engineering practice.

The design standards contained herein are minimal and alternates may be approved, provided such alternates are to a higher standard than those set forth. Exceptions to these standards may be allowed by the City Engineer when it can be determined that such exceptions are in the best interest of the City.

### **V-2. DESIGN GUIDELINES:**

Each improvement shall be designed such that concentrated flow or the increase of the rate of flow of water onto downstream properties does not occur. An exception to this may be permitted by the Engineer if there are adequate downstream facilities provided to handle the total flow without adverse affect on other properties. In this event, the Developer may be required to participate in the cost of said facilities, and/or obtain easements or other rights as needed.

Unless an individual project requires the diversion of water to conform to a comprehensive drainage plan, water shall be received and discharged at the locations which existed prior to development and as nearly as possible in the manner which existed prior to development. Should diversion be required, sufficient work shall be done upstream and/or downstream to provide all affected properties at least the same level of flood protection as existed prior to development and a FEMA Elevation Certificate filed as may be required by the City Engineer. All drainage facilities other than those within the road right of way shall be maintained by an entity with taxing powers if possible. The Developer shall complete arrangements for such an entity or some other approved method prior to filing of the Final or Parcel Map.

#### **A. Hydrology Calculations**

The basis to be used to compute the total volume of runoff from a development with an area less than 200 acres shall be the Rational Method.

All calculations shall be prepared by a registered professional engineer with a current license to practice in the State of California. Standard Drawing E-1, E-2, E-3, E-4 and E-5 are available for use as part of the hydrology calculations. In computing runoff in a partial development, adequate provisions must be made for the drainage of the overall improvements and/or drainage tributary. Hydrology calculations shall be based upon ultimate land use designations in accordance with the adopted General Plan.



The hydrology calculations shall include a hydrology map showing the following information

1. The map shall be on a topographic map of sufficient scale to show drainage patterns and quantities of runoff.
2. Drainage area in acres, time of concentration, rainfall intensity and runoff coefficient.
3. Design flow to each inlet structure. Identify each inlet by numbers or letters.
4. Show and identify all storm drain pipes, their sizes, Q25 and/or Q100 design flow.
5. Show and verify with legible contours or other adequate means, all runoffs entering the subject development. If previous studies were used, then they must be referenced.
6. Show the total runoff leaving the development.
7. All off-site drainage areas must be shown with an analysis of the interim and ultimate Q's from those areas.

Include the necessary supporting calculations or reference and submit a copy of a previously accepted study.

For special design problems or drainage areas in excess of 200 acres, where the Rational Method is not practical, the design engineer shall provide all documents as are necessary to confirm his or her hydrology computations. Improvements in natural water courses will not normally be approved unless the capacity of the improved waterway is at least that of the natural waterway. All waterways shall be designed for an average recurrence interval of 100 years, with 1-foot (0.3m) freeboard.

All building pads or first floor elevations shall be at least one foot above the 100-year storm water surface elevations determined by land use and general plan. Any construction of any building within a designated floodway shall require flood certificate approval by the Design Engineer and the City Engineer, all in accordance with the FEMA Regulations.

## **B. Hydraulic Calculations**

In order to provide a uniform drainage system in the City of Paso Robles, the following criteria will be used in all hydraulic computations unless approval otherwise is received in writing from the City Engineer.

1. Flow Computations - All flow computations shall be in accordance with the following:
  - a. Manning's Formula shall be used to compute capacities of all open and closed conduits. (Refer to Bureau of Public Road charts for solutions of Manning's Formula). Other method of computation may be submitted to the City Engineer for consideration.
  - b. The "n" values to be used in Manning's Formula shall conform to the following:



- |     |  |       |
|-----|--|-------|
| 1)  | Concrete cast-in-place or pre-cast pipe          | 0.013 |
| 2)  | Vitrified Clay pipe                              | 0.013 |
| 3)  | Corrugated Metal Pipe (C.M.P.) 100% paved        | 0.015 |
| 4)  | Corrugated Metal Pipe (C.M.P.) with paved invert | 0.019 |
| 5)  | Corrugated Metal Pipe (C.M.P.) plain unlined     | 0.024 |
| 6)  | Asbestos-cement pipe                             | 0.011 |
| 7)  | Open channel with gunite lining                  | 0.018 |
| 8)  | Asphaltic concrete (smooth) road berms           | 0.015 |
| 9)  | Sack concrete rip rap                            | 0.030 |
| 10) | Grouted rock rip rap                             | 0.030 |
| 11) | Loose rock rip rap                               | 0.035 |
| 12) | Open channel with paved bottom                   | 0.025 |
| 13) | Earth channel                                    | 0.030 |
| 14) | PVC or HDPE                                      | 0.009 |

2. The hydraulic calculations shall include the following general information:

a. **Closed Conduits**

Closed conduits shall be designed considering (at least) the following hydraulic elements:

- Pipe friction losses determined by Manning's equation.
- Entrance and exit losses.
- Tailwater impacts.
- Entrance control headwater.

For each length of pipe, the hydraulic grade line (hgl) at the pipe entrance and exit shall be determined assuming both inlet control and outlet control. The more restrictive shall control.

Readily available design charts maybe used as long as copies of charts are included in the drainage report which is submitted to the City Engineer for review and approval.

The City Engineer may require more complete analysis if he/she determines conditions merit a more thorough study. This additional analysis may include analysis of junctions, analysis of system surcharge, and the like.

b. **Open Channels**

Open channels shall be designed based on Manning's equation. If necessary, the impacts of culverts, bridges or other hydraulic elements shall be considered.

The City Engineer may require more complete analysis if he/she determines conditions merit a more thorough study. This additional analysis may include determination of the water surface profile, analysis of hydraulic jumps, analysis of critical sections, analysis of erosion and/or sedimentation, and the like.

Computer solutions will be considered on a case-by-case basis. As various programs are re reviewed, a list of acceptable programs will be developed.



c. **Design Criteria**

The storm drain system shall be designed to meet the following conditions.

- 1) The hydraulic grade line shall be a minimum of 0.50 feet below the elevation of inlet grates and manhole covers of all structures for a design storm of 25 years. Said gradient shall be shown on the profile for storm drain systems.
- 2) Storm drain systems shall be designed for the 25-year storm. In aump condition a secondary overland flow shall be included such that during the 100-year storm, all buildings or first floor elevations shall be at least one foot (1') above the 100-year storm. In some cases, the City Engineer may require that the storm drain system be designed for a 100-year storm frequency.
- 3) Design of flow in the streets shall limit the width of flow as shown in Drawing No. E-5. Where the street capacity is exceeded, a storm drain or other facilities shall be provided to convey the excess flows. In all cases, the 10-year storm shall be contained within the right-of-way.

3. Acceptable facilities to convey storm flow shall be as follows:

a. Closed Conduits - Shall be of either cast-in-place or pre-cast reinforced concrete pipe RCP, CMP (hot-dipped galv.), PVC, HDPE or an approved equal.

- 1) Minimum pipe diameter allowable on any public storm drain shall be 18 inches. A lesser size may be used for down drains on cut or fill slopes if approved by the Engineer.
- 2) Minimum design velocity in closed conduits shall be 2 f.p.s. when conduit is flowing to capacity and should not exceed 15 f.p.s.
- 3) Cover requirements shall be as shown in The California Department of Transportation (CALTRANS) Highway Design Manual Table 854.8 or as approved by the City Engineer.

At locations where the general minimum cover requirements cannot feasibly be obtained, the conduit shall be either encased in concrete or provided with a concrete cover or protected by other methods as are approved by the manufacturer and approved by the Engineer for each individual circumstance.

b. Open Conduits

- 1) Open conduits may be natural watercourses earthen channels, or channels lined with the materials listed below, provided that the selected lining material is approved by the Engineer for the particular channel reach:



- i) Low-growing grass, which will form a thick, dense sod. The proposed grass mixture is to be submitted to and approved by the Engineer.
  - ii) Geo-Textile materials.
  - iii) Rock slopes protection in accordance with CALTRANS specifications (Section 72).
  - iv) Concreted-rock slope protection facing class, Method B Placement.
  - v) Sacked concrete slope protection.
  - vi) Concrete slope paving.
  - vii) Air-blown mortar.
- 2) Minimum velocity for channels flowing full, with freeboard shall be two feet per second. (2 FPS).
- 3) Maximum velocity shall be as follows:
  - i) Earth channels not to exceed velocity that would cause erosion (maximum 5 feet per second).
  - ii) Lined channels not to exceed 10 feet per second or as approved by the Engineer.
- 4) Freeboard of at least one foot (1 ft) or 0.2 of the specific energy (whichever is greater) shall be provided at design capacity for all channels. Where linings are required, they shall extend to the full height of freeboard.
- 5) For natural waterways, the design flow may be allowed in the natural overflow area, and freeboard as specified above exists between the water surface and adjacent ground.
- 6) Drainage facilities shall be so constructed and areas adjacent to channels so graded that roadside drainage will enter in a manner that will prevent erosion within the rights-of-way. This will often require construction of side inlets and collector ditches to carry side flow to inlets or natural drainage course.



### **C. Plan Preparation**

Storm drain construction plans shall include the following information:

1. Flow line elevation of each pipe and structure.
2. Top of structure elevation.
3. Water surface elevation at each structure.
4. Hydraulic gradient.
5. Pipe material, size, length and gradient.
6. Outlet condition - existing channel conforms, capacity and geometries.

### **D. Capacity**

Special provisions shall be made by the Consultant to insure that the inlet flow line elevations and the capacity of the drainage system is such that it may be extended to serve and to properly handle the entire drainage basin at the time of ultimate development, and in accordance with the General Plan. This is to include the entire upstream portion and the portion of the basin outside the development, regardless of existing conditions.

Storm drains for "Blue Line" Streams or Hillside Development shall be sized to convey a minimum 25-year storm with provision to convey the difference between the 100-year frequency storm and the 25-year storm by an overland route to a drainage system with sufficient capacity to convey the 100-year frequency storm. All habitable buildings/structures shall have a minimum one-foot of freeboard.

### **E. Alignment**

The diversion of natural drainage will be allowed only within the limits of the proposed improvement. All natural drainage must leave the improved area at its original horizontal and vertical alignment and with approximately the same discharge velocity as existed prior to development unless a special agreement indemnifying the City has been executed with the adjoining property owners. This agreement shall be in a form approved by the City Engineer. Modification of a flood plain shall be done in conformance with Federal Management Emergency Management (FEMA) regulations. The developer shall provide supporting data for the Map Revision required per said regulations.

The general location for storm drainage lines shall be twelve feet northerly or westerly of the centerline of a street (See Standard Drawing No. U-1). Other general requirements for storm drains are as follows:

1. Storm drainage lines are to be parallel with the centerline of streets unless impracticable. The designer should avoid meandering, offsetting, and unnecessary angular changes (none to exceed 90°).
2. Provide junctions between converging lines in such a manner as will minimize losses and utilize available velocity head, and locate the centerline of the influent and effluent lines so that they will be approximately in the same plane and be as nearly as possible parallel to the resultant vector of the converging lines.



3. The vertical alignment shall be so designed to eliminate any ponding within the drainage system, other than where sump pumps are provided. Sump pumps will only be allowed when installation of a gravity drainage system is not reasonably available or feasible, as determined by the City Engineer.
4. Existing open ditches, paved channels, and swale flows shall be maintained as nearly as possible in their existing alignment.

#### **F. Easement**

Drainage facilities must be located in a public street, road or lane, or within a public drainage easement. Where upstream storm watersheds are of a public nature, all necessary dedications of easements "For Drainage Purposes" shall be dedicated to the City for lines to be constructed on private property. Said easements must be secured before the construction plans will be approved for construction.

Where a minor improvement of a drainage facility falls on adjacent property, written permission from the adjacent property owners for such construction and a copy of the approval of the adjacent owners shall be submitted to the City Engineer prior to approval of the improvement plans. Agreements between property owners shall hold the City harmless from any damage claim arising from said agreement.

Drainage easements shall be used for drainage purposes exclusively and shall not be combined with easements required for other public utility purposes unless it can be shown to the Engineer that dual use of said easement will not be conflicting.

For natural waterways, a drainage easement or right-of-way when required shall be provided which includes the entire waterway area plus freeboard (min. 1'). Prior to final approval, the easement shall be staked by the subdivider's engineer and reviewed by the City Engineer. In the case of a natural waterway having banks with side slopes steeper than two horizontal to one vertical, the right-of-way may be required to be increased to provide width for not less than 2 to 1 slopes from the existing toe of bank, plus a 10-foot wide buffer strip. Additional right-of-way will also be required where unstable ground conditions exist.

1. Easements For Closed Conduits - Easements for closed conduits shall meet the following requirements:
  - a. Minimum width of ten feet (10') with pipe at quarter point, on north or west and where the "Influence Line" of adjacent structural footings will not project over or into said drainage line. Whenever possible, rights-of-way for closed conduits shall be along or adjacent to property lines and outside of areas where structures are planned.
  - b. On pipes of 24" diameter and greater, or trenches exceeding 5 feet in depth, the easement shall have additional width to provide ample working space as required by the Engineer.
  - c. Provide access and working space rights.
2. Property Rights For Open Channels - Property rights for major and intermediate open conduits shall have sufficient width to contain the open channel with side slopes, and at least one fifteen foot (15) service road. All channels having top width in excess of 50 feet shall have a 15-foot service road on each side of the channel.



## **G. Drainage Structures**

The design and construction of drainage structures and special drainage items shall conform to the designs contained in these Standards and Specifications (unless otherwise noted). Special care must be taken to insure that all drainage structures and pipe are designed at such a capacity that the drainage system may be extended to serve the entire drainage basin at ultimate development in accordance with the General Plan. The rational formula ( $Q=CIA$ ), with all numerical quantities, shall be indicated on the drainage plans at each drainage structure.

### **1. Manholes**

- a. Standard pre-cast concrete manholes shall be used wherever feasible. When cases arise where special manholes or junction boxes are required, the design shall be approved by the Engineer. (Standard Drawing No. E-7.1).
- b. Manholes shall be located at junction points, changes in gradient and changes in conduit size. On curves with pipe radii of 200 feet to 400 feet, manholes shall be placed at the BC or EC of the curve and on 300-foot maximum intervals along the curve. On curves with radii exceeding 400 feet, manholes shall be placed at the BC or EC of the curve, and on 400-foot maximum intervals along the curve for pipes 24 inches and less in diameter, and 500-foot maximum intervals along the curve for pipes greater than 24 inches in diameter. Curves with radii less than 200 feet will be handled on an individual basis.
- c. On other than curved piping, spacing of manholes or inlets, of such size as to be enterable for maintenance, shall not exceed 500 feet for drains 24 inches and smaller in diameter and 600 feet for pipes greater than 24 inches in diameter, except under special approved conditions. The spacing of manholes shall be nearly equal wherever possible.
- d. All manholes or junction boxes must have standard 24 inch diameter manhole covers and must be located out of the gutter line. Manholes shall be accessible for maintenance.

### **2. Inlets**

- a. Gutter inlets shall be in accordance with Standard Drawing No. E-8 or other approved special inlets.
- b. Inlets shall be spaced so that water flow does not exceed a distance of 8 feet horizontal from curb face for a 10-year storm or 12 feet horizontal from curb face for a 25-year storm. Calculations must be submitted for "pass by" water at each inlet, and all water for the 25-year storm must be collected by the system at the low point of the project. Inlets shall also be spaced so that a 100-year storm will not cause any damage and can be contained within the right-of-way.
- c. Grates shall be adequate for AASHTO's HS-20 traffic loading and shall be double dipped hot galvanized or approved equal.



### **3. Junction Boxes**

- a. Junction boxes shall be constructed of Class "A" reinforced Portland cement concrete or fabricated from reinforced concrete pipe sections where size limitations permit.
- b. Minimum wall thickness for poured-in-place reinforced concrete junction boxes shall be 6 inches.
- c. The inside dimensions of junction boxes shall be such as to provide a minimum of 3 inches clearance on the outside diameter of the connecting pipes.
- d. All junction boxes shall have the standard 24-inch manhole cover. (Pinkerton A640, or approved equal, per Standard Drawing F-4).

### **4. Reinforced Concrete Box Culverts, CMP and Structural Plate Arch Culverts**

All materials, designs and construction shall conform to the requirements of the State Specifications and State Standard Drawings unless otherwise specified by the City Engineer.

### **5. Headwalls, Wingwalls, Endwalls, Trash Racks and Railings**

- a. All headwalls, wingwalls, and endwalls shall be of Class "A" reinforced Portland cement concrete.
- b. All headwalls, wingwalls and endwalls shall be considered individually and shall be, in general, designed in accordance with State Standards or approved by the Engineer.
- c. Trash racks shall be provided where in the opinion of the Engineer they are necessary to prevent clogging of culverts and storm drains.
- d. On corrugated metal culvert drains, preformed metal end sections may be utilized with the approval of the Engineer.
- e. Metal guardrail or type "L" delineator paddles may be required by the Engineer at culverts, headwalls and box culverts and on steep side slopes. When so required, the railing or delineators shall be installed in accordance with State Standards and Specifications.

### **6. Drainage Pumps**

The use of drainage pumps shall be avoided whenever possible. They shall be used only with the approval of the City Engineer.



## **H. Detention Basins**

1. A detention basin is defined as any drainage facility which is used to detain the rate of flow storm run-off from a site by sizing the out flow pipe or channel so that the rate of flow from the property is not increased after development. The accumulating run-off from the development shall be stored in the detention basin until it drains away. Such a basin will be required of all development unless otherwise approved by the City Engineer.
  - b. Volume of Storage** - The required volume of storage shall be determined by the difference in the 10-year storm peak run-off of the undeveloped site and the 100-year storm run-off of the developed site. The outlet pipe or channel shall be sized for the 10-year storm peak run-off rate for the undeveloped site and a non-erosive spillway of sufficient size shall be provided together with a twelve foot (12") all weather access road. Design methods of providing drainage retardation or detention will be subject to the approval of the City Engineer.
  - c. Fencing Requirements**

Fencing is optional at the discretion of the Engineer if the maximum water depth obtainable does not exceed four feet (4') and the side slopes are 4 to 1 or flatter.
  - d. Right-of-Way**
    - 1) The top of bank shall be located a minimum of five feet (5') inside the right-of-way line or as dictated by set-back requirements. If a fence is required it shall be located from 4 inches (4") inside the right-of-way line except where setbacks are required as part of the conditional use permit.
    - 2) Property required for drainage basins shall be deeded in fee to the City.
  - e. Landscape Requirements**

All landscaping shall be designed by a licensed Landscape Architect and installed in accordance with plans and specifications meeting provisions of the Standard Landscaped Drainage Basin (See Standard Drawing No. E-11.1 and 11.2), the conditions of the project and the approval of the Community Development Department.

## **I. Channels, Outfalls and Cross Culverts**

All channel realignment, improvement and cross culverts shall be shown on the improvement plans and shall conform to the requirements of these Standards and Specifications. No diversion to roadside ditches will be allowed from natural drainage courses.

1. Open Channels
  - a. Realigned channels shall be required to be permanently lined to an elevation of at least 1.0 foot above the design waterline. The side slopes for realigned channels shall not exceed 1:1 on the lined portion and 2:1 on the unlined portion.



- b. For all intermediate or major channels, either realigned or natural, within an improvement, the following information shall be shown on improvement plans in addition to information heretofore required.
  - 1) Typical Sections
  - 2) Profile of the existing channels for a minimum of 300 feet each side of the development in order to establish an average profile grade through the development.
- c. Fencing requirements for channels shall be as follows:
  - 1) Natural channels need not be fenced, except where special hazards exist. (Hazardous Flow = Velocity (fps) x Depth (ft.) of Flow (if greater than 6).
  - 2) For constructed channels not excepted from fencing, a five-foot high chain link fabric with tension wire shall be installed on each side of the right-of-way. At all road intersections fencing shall prevent public access to channel or culvert, and 14-foot wide chain link drive gates shall be provided at all points of access to maintenance ways, or to channels not requiring maintenance ways.
  - 3) For minor channels or natural water courses with depth less than 3.0 feet and for side slopes flatter than 4 to 1 on other channels, the City Engineer may allow the fence requirement to be waived.
  - 4) The fence shall be located six inches (6") within the required easement lines and shall provide sufficient room for maintenance vehicles as set out, or as specified by the City Engineer.

## 2. Outfalls

- a. All drainage outfalls shall be shown both in plan and profile on the improvement plans for a distance of 500 feet or until a definite "daylight" condition is established.
- b. When improvements have more than one phase, the drainage outfall shall be shown as extending the property boundary, and beyond if required, although it may not be constructed with the current phase development. All temporary outfalls shall be shown both in plan and profile on improvement plans.

## 3. Cross Culverts

- a. Cross culvert design shall be determined on the basis of a twenty-five-year storm with no head except culverts for blueline streams, which shall be designed for the 100-year storm.

Waterways placed in closed conduit systems may be designed for full conduit capacity and pressure flow. The hydraulic entrance condition at a closed conduit minor waterway shall be such that the 10-year discharge will have the specified



freeboard in the upstream channel or waterway and that the 100-year discharge will be contained within the banks of the upstream waterway or drainage easement. The entrance to the closed conduit minor waterway may be submerged provided that the above criteria are satisfied.

Any rise in floodplain water surface will only be permitted in accordance with FEMA regulations.

- b. Cross culvert profile shall be determined by the average profile of the channel for a minimum distance of 300 feet each side of the installation. However, the City Engineer may require more than the minimum.

### **V-3. MATERIALS**

All drainage items shall be of the material and construction methods as required in accordance with the applicable portions of the State Specifications as herein noted, specified or modified. Use of Plastic (HDPE) storm drainpipe will be permitted when specific application is approved by City Engineer.

- A. Reinforced Concrete Pipe (RCP)** - Shall conform to the specification of AASHTO Designation M-170 latest edition.
- B. High Density Polyethylene (HDPE)** - Shall be smoothlined and have pressure coupling.
- C. Structure Backfill**

Backfilling operations shall conform to the following requirements: Material for use as structure backfill shall have a sand equivalent value of not less than 20. The percentage composition by weight as determined by laboratory sieves shall conform to the following grading: (Check Green Book)

<u>Sieve Size</u>	<u>Percentage Passing sieves</u>
3"	100
No. 4	35-100
No. 30	20-100

#### **D. Concrete Structures**

Concrete structures shall be in accordance with these Standards and Specifications and in addition they shall conform to the requirements of Section 51 of the State Specifications.

#### **E. Reinforcement**

Reinforcement shall conform to the requirements of Section 52 of the State Specifications.

#### **F. Portland Cement Concrete**

Portland Cement Concrete shall be class "A" or "B" as specified and conform to the requirements of Section 90 of the State Specification and **Drawing No. 15.1, 15.2, and 15.3.**



#### **G. Gunite Lined Channels**

1. Gunite lined channels shall be mesh reinforced.
2. Portland cement shall conform to the requirement of Section 90-1.02A of the State Specifications.
3. Sand shall be washed sand and shall be hard, dense durable, clean and sharp and graded evenly from fine to coarse within the following limits:

<u>Sieve Size</u>	<u>Percentage Passing by weight</u>
3/8"	100
No. 4	97-100
No. 8	75-90
No.16	55-75
No.30	30-50
No.50	10-25
No.100	2-10
No.200	0-5

Sand shall be free from organic matter and shall not exceed the limits prescribed in ASTM C-33.

The materials above shall be mixed in the proportions of 1 part Portland cement to 4-1/2 parts of sand, by volume.

#### **H. Concrete Lining**

Concrete lined channels shall be constructed of the materials and in accordance with Section 72-4 of the State Specifications.

#### **I. Grouted Rip-rap**

Grouted rip-rap shall conform to the materials and methods called for in state specifications 72-5.01.

#### **J. Fencing**

1. Chain link fence for drainage channel enclosure shall be Type CL-6 as specified in Section 80-101 of the State Specifications, with or without extension arms and barbed wire as specified.
2. Chain link fence shall be of the materials and construction as specified in Section 80-4 of the State Specifications.
3. Drive gates and walk gates will be provided, complete with master keyed locks and-keys, at such locations as specified by the Engineer for the purpose of maintenance vehicles and personnel.



#### **V-4. CONSTRUCTION GUIDELINES**

##### **A. Reinforced Concrete Pipe**

1. Excavation for pipe shall conform to Section VII-13-B of these specifications except that where tongue and groove pipe is utilized excavation need only be to one inch below the outside diameter of the pipe in uniform material and three inches below the outside of the pipe in rocky material.
2. Laying of reinforced concrete pipe: Section 65-1.07 of the State Specifications.
3. Jointing: Section 65-1.06 of the State Specifications.
4. Trench backfill: Section VI-20 of these Specifications.

##### **B. Structure Backfill**

1. Structure backfill shall not be placed until the structure footings or of the portions of the structure or facility have been inspected by the Engineer and approved for backfilling. No backfill material shall be deposited against the back of concrete abutments, concrete retaining walls, or the outside walls of cast-in-place concrete culverts until the concrete has developed a strength of not less than 2,500 pounds per square inch in compression as determined by test cylinders cured under conditions similar to those prevailing at the site and tested in accordance with Test Method No. California 521 (CALTRANS), or until approved by the City Engineer.
2. Backfill material shall be placed in horizontal, uniform layers not exceeding 0.67 foot in thickness, before compaction, and shall be brought up uniformly on all sides of the structure of facility. Each layer of backfill shall be compacted to a relative compaction of not less than 90 percent, except that the upper 2 feet shall be compacted to 95 percent. Backfill outside the roadway prism shall have a sand equivalent of not less than 20 and shall be compacted to not less than 90 percent. It shall conform to the above grading limits.
3. At the option of the contractor, backfill material conforming to the requirements hereinafter specified may be used at the following locations:
  - a. Footings for slope protection, slope paving and aprons.
  - b. All headwalls and culvert wingwalls.
  - c. Retaining walls, except for portions under any roadbed.
  - d. Drop inlets in median areas or in traffic interchange loops.
4. The backfill material at the above locations may consist of material from excavation, free from stones, or lumps exceeding 2-1/2 inches in greatest dimension, namely, clay or adobe type material, vegetable matter or other unsatisfactory material, and shall be compacted to a relative compaction of not less than 90 percent. When the material from excavation is unsuitable for use as backfill, it shall be disposed of as directed by the



Engineer, and suitable material approved by the Engineer shall be furnished by the Contractor for the backfill.

5. Trench-dams (soil plug) shall be installed in areas of potential ground water migration.

### **C. Gunite Lined Channels**

1. **Channel preparation** - The channel shall be trimmed to the line and grade and cross section as shown on the plans within the following limitations:

Allowable deviation from profile 0.05 foot; allowable deviation of slope and line 0.15 foot in any 10-foot length section of channel.

Care shall be taken to prevent excavating below ditch grade line or beyond the slope lines. Any deviation in excess of the specified tolerance may not be backfilled with earth, but shall be corrected by the placement of additional gunite materials. The channel shall be clean, damp and free from any rubbish or trash or free flowing or standing water prior to initiating guniting operations.

2. **Placing of Material** - channel lining shall consist of a mixture of Portland Cement and sand, mixed dry, passed through a flexible hose, hydrated at the nozzle and deposited upon a dampened subgrade by air pressure. The final ditch lining shall not be less than 3 inches in thickness and shall conform to the dimensions shown on the plans. The pneumatic pressure at the gage shall remain uniform at the following pressures:

- a. For hose length up to 100 feet - 45 psi.
- b. Where the length of hose exceeds 100 feet the pressure shall be increased 5 psi for each additional 50 feet of hose.

3. **Weep Holes** - Weep Holes shall be provided at intervals of 10 feet midway between construction joints. The holes shall be backed by a minimum of 1 cubic foot of concrete aggregate tied in a burlap bag to insure proper operation of the weep hole. The aggregate shall extend at least 0.5 foot above the weep hole.

All weep holes shall be 2-1/2" diameter and placed at an elevation of 1 ft. above flowline of channel.

4. **Curing** - Shall be accomplished by the pigmented curing compound method as specified in Section 40-1.11C of the State Specifications, except that the manual operation of an unshielded spray nozzle will be permitted. Surface shall be kept moist or wet until the curing compound is applied. Curing compound shall not be applied to surfaces of construction joints.

### **D. Concrete Lined Channels**

Weep Holes shall be provided at intervals of 10 feet midway between construction joints. The holes shall be backed by a minimum of 1 cubic foot of concrete aggregate tied in a burlap bag to insure proper operation of the weep hole. The aggregate shall extend at least 0.5 foot above the weep hole.

All weep holes shall be 2-1/2" diameter and placed at an elevation of 1 ft. above flowline of channel.



#### **E. Grouted Rock Rip-rap Channels**

Weep hole pipe consisting of two and one-half (2-1/2) inch diameter galvanized iron pipe shall be placed through the grouted rock rip rap along both sides of the channel approximately one foot (1') above the channel invert. spacing of weep holes shall be such as to provide complete drainage of the foundation and filter material and shall not exceed ten feet (10').